Monitoring athletes through self-report: Factors influencing implementation

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Abstract

Monitoring athletic preparation facilitates the evaluation and adjustment of practices to optimize performance outcomes. Self-report measures such as questionnaires and diaries are suggested to be a simple and cost-effective approach to monitoring an athlete's response to training, however their efficacy is dependent on how they are implemented and used. This study sought to identify the perceived factors influencing the implementation of athlete self-report measures (ASRM) in elite sport settings. Semi-structured interviews were conducted with athletes, coaches and sports science and medicine staff at a national sporting institute (n = 30). Interviewees represented 20 different sports programs and had varying experience with ASRM. Purported factors influencing the implementation of ASRM related to the measure itself (e.g., accessibility, timing of completion), and the social environment (e.g., buy-in, reinforcement). Social environmental factors included individual, inter-personal and organizational levels which is consistent with a social ecological framework. An adaptation of this framework was combined with the factors associated with the measure to illustrate the inter-relations and influence upon compliance, data accuracy and athletic outcomes. To improve implementation of ASRM and ultimately athletic outcomes, a multi-factorial and multi-level approach is needed.

Key words: Training diary, questionnaire, wellbeing, athletic injury, overtraining.

Introduction

An increasing scientific approach to athletic preparation involves regularly monitoring the external and internal loads experienced by an athlete, and how they respond to these loads (Coutts and Cormack, 2014). Athlete monitoring may provide coaches and service providers with a greater degree of certainty when prescribing and adjusting training load, with the intention of optimizing adaptation and performance whilst reducing the risk of overtraining, injury and illness (Coutts and Cormack, 2014; Halson, 2014; Roos et al., 2013; Taylor et al., 2012). Therefore it is recommended that monitoring be performed during periods of heavy training (Buchheit et al., 2013; Kenttä et al., 2006) or throughout athletic preparation (Coutts and Cormack, 1995; Hooper and Mackinnon, 1995; Meeusen et al., 2013; Morgan et al., 1987). However, implementation of athlete monitoring requires an investment of time, financial and human resources to obtain, analyze and utilize the data effectively.

Self-report measures such as questionnaires and diaries are a relatively simple and inexpensive approach to monitoring athlete responses (Halson, 2014). There is

also growing support in the literature suggesting self-report measures may be more sensitive and reliable than traditional physiological, biochemical and performance measures (Buchheit et al., 2013; Coutts et al., 2007; Halson, 2014; Meeusen et al., 2013; O'Connor et al., 1989; Raglin et al., 1990; Urhausen and Kindermann, 2002). Athlete self-report measures (ASRM) include perceptions of wellbeing (e.g. fatigue) and psychological variables (e.g. mood) which are influenced by both training and non-training stressors (Kellmann, 2010; Rushall, 1990). It has been well documented that disturbances in self-reported wellbeing are associated with overreaching and overtraining (Hooper et al., 1997; Meeusen et al., 2013; Morgan et al., 1987; Raglin and Wilson, 2000; Urhausen et al., 1998). Such disturbances may also reflect an increased risk of injury (Andersen and Williams, 1988; Galambos et al., 2005; Johnson and Ivarsson, 2011; Junge, 2000) and illness (Anglem et al., 2008; Zorrilla et al., 2001).

The supporting literature for ASRM has typically used published questionnaires with evidence of validity and reliability such as the Profile of Mood States (McNair et al., 1981), Recovery-Stress Questionnaire for Athletes (Kellmann and Kallus, 2001) and Daily Analyses of Life Demands for Athletes (Rushall, 1990). Whilst such measures may also be used in the applied setting, their length, narrow focus or lack of specificity to the sporting context has led many sports programs to develop their own ASRM to meet their needs (Gastin et al., 2013; Kavaliauskas, 2010; Taylor et al., 2012). This reflects an attempt to improve implementation by reducing athlete burden and increasing relevance, however this may be at the expense of validity and reliability. To date, the design and implementation of ASRM in the applied setting are typically informed by empirical measures and personal experience, with a need for further research to optimize practices.

The design of an ASRM should aim to minimize the inherent limitations of self-report, namely measurement error and conscious bias (Baldwin, 2000). These threats to validity have been attributed to cognitive and situational factors (Brener et al., 2003). Cognitive factors include miscomprehension and recall error (Brener et al., 2003), which may be addressed with clear instruction (Vinokur et al., 1979), and minimizing the period of recall (Shiffman, 2000). Ensuring understanding of the overall task may also improve motivation to respond accurately, thus reducing conscious bias (Vinokur et al., 1979). Conscious bias is often the result of an individual responding in a socially desirable manner, generally over-reporting

favorable responses and under-reporting unfavorable responses. In the sports setting, this may mean athletes 'faking good' to appear to be coping or to gain selection (Ekegren et al., 2014a), or 'faking bad' to have their training reduced (Meeusen et al., 2013). Therefore it is important to not only consider the design of a self-report measure, but also the individual and situational factors which may influence the ability to obtain meaningful, accurate and consistent data from athletes.

Drawing upon research on implementation in other fields such as education and health, there is strong evidence that implementation strategies affect the outcomes of promotion and prevention programs (Durlak and DuPre, 2008). Such research has also highlighted the complexity of implementation, identifying 23 ecological factors affecting the implementation process related to the community, organization, provider, support and the system being implemented (Durlak and DuPre, 2008). These factors are likely inter-related and specific to real-world contexts, precluding rigorous experimental investigation (Durlak and DuPre, 2008; Meyers et al., 2012). Therefore it is useful to apply qualitative techniques to provide preliminary insight into a particular implementation process. It is also useful to apply a conceptual framework to help organize and communicate ecological factors and guide implementation strategies (Durlak and DuPre, 2008; Meyers et al., 2012). One such framework is a social ecological model which outlines the interactions between organizational, inter-personal and individual levels (McLeroy et al., 1988).

In a sporting context, interactions between social ecological levels has been considered for the implementation of sports injury prevention initiatives. The hierarchical structure within sports (athlete, team, coach, club, regional, national and international sporting organizations) has been used to describe the responsibilities and potential to effect change (Emery et al., 2006), and hence the need for multi-level implementation strategies (Finch and Donaldson, 2010). Similar social ecological considerations are also relevant for obtaining data for injury surveillance (Ekegren et al., 2014a), a task more closely aligned with ASRM. Ekegren et al. (2014a) identified personal (e.g. perceptions), socio-contextual (e.g. staff/resources, culture, support and leadership) and system (e.g. technical issues, simplicity and utility, and compatibility with existing procedures) factors which influenced the implementation of an injury surveillance system in community sports clubs.

To identify and address factors influencing the implementation of ASRM it is important to first seek the perspectives of end-users (Donaldson and Finch, 2012). The end-users of ASRM are the athletes who complete the measure, along with their coach and supporting sports science and medicine staff who use the information. One approach is to consult end-users throughout the development and pilot of a new measure (Shrier et al., 2014), however in many cases ASRM are already in place. Therefore the aim of this study was to consult the end-users of pre-existing ASRM to better understand the factors influencing implementation in the applied sport setting and apply this to a social ecological framework.

Methods

Participants

A stratified purposeful sample of eight athletes, seven coaches and 15 sports science and medicine staff (SSMS) from a national sporting institute volunteered to participate in the study. Participants represented 20 different sports programs including 10 international-level individual sports (rowing, swimming, track and field, tennis, sailing, road cycling, track cycling, mountain biking, winter sports, boxing), 4 international-level team sports (women's water polo, women's football, rugby union, rugby league), and 6 elite youth team sports (men's football, men's and women's basketball, hockey, netball, Australian football). The subgroup of coaches included both sport-specific coaches and strength and conditioning coaches. The subgroup of SSMS included staff from the disciplines of physiotherapy, physiology, recovery physiology and psychology, hence the larger number of participants to capture the diversity of views within this subgroup.

Athletes had been at the national sporting institute for between 3 months to 10 years (4.9 ± 3.7 years). Staff had been at the national sporting institute for between 6 months and 24 years (6.4 ± 6.4 years) and had been working with athletes for 4 to 27 years (12.2 ± 6.9 years). Fourteen staff had additional experience in amateur sports, nine had experience in professional sports and ten had experience in international sports settings. Thirteen staff also had experience as an athlete at a sub-elite or elite level.

Participants had a range of experience with ASRM, including both the duration of exposure (3 months-15 years; 4.8 ± 3.4 years) and the measures used. Subjects were currently using various in-house or customised commercial measures. These measures took a multi-disciplinary approach, briefly assessing an athlete's subjective well-being alongside behaviors such as training, recovery and nutrition. For the purposes of this research, the particular characteristics of the ASRM used (e.g. questions, format) were less relevant, rather the underlying factors of implementation were discussed. This study was approved by both the university and national sporting institute human research ethics committees. Written informed consent was obtained from participants prior to commencement.

Procedure and analysis

All interviews were conducted one-on-one by the primary author at the national institute of sport at the convenience of the interviewee and were approximately 20 minutes in duration. In accordance with a grounded theory approach (Corbin and Strauss, 2008), a semi-structured interview outline was developed to allow novel insights to emerge. The interview commenced with background questions, then addressed the benefits and negatives of completing an ASRM; how the ASRM were implemented; how accurately athletes responded; who looks at the data; what actions take place; and sought suggestions for improvement. Interviewees were requested to elaborate on points or prompted for additional information as necessary.

Interviews were audio recorded and supplemented with brief handwritten notes.

Audio recordings and notes were coded by a letter representing the interviewee's role (A=athlete, C=coach, S=SSMS) and numeric identifier. The primary author transcribed all interviews verbatim from the audio recordings and re-checked them for accuracy. Transcripts were imported into NVivo qualitative data analysis software (QSR International Pty Ltd. Version 10.0, 2012) for data management. To minimize the potential of researcher bias, a grounded theory approach to data analysis and interpretation was used (Corbin and Strauss, 2008). The process, as outlined below, was also triangulated amongst all authors.

During the early phases of coding, transcripts were read and information-rich or interesting sections were identified (meaning units). Each meaning unit was analysed in consideration of its context and coded as a node.

Evolving nodes were continuously compared, grouped and distinguished according to their properties and dimensions. As coding of transcripts progressed, meaning units were coded to existing nodes or, if they did not fit an established node or offered a novel insight, a new node was created. Provisional hypotheses of how the concepts related were noted and revised throughout the process and once all transcripts had been coded, nodes were grouped in to lower and higher-order themes.

Results

Analysis of the transcripts revealed 681 meaning units which characterized the factors of ASRM implementation. The grouping of meaning units revealed eight factors associated with the measure (Table 1), and six associated with the social environment (Table 2). These factors and their inter-relations are summarized in Figure 1.

Table 1. Thematic structure of the influence of the athlete self-report measure (ASRM) on implementation.

Higher order theme	Lower order theme	Representative meaning unit	Number of interviewees			Total meaning units
			Athlete (n=8)	Coach (n=7)	SSMS (n=15)	
Mode	**Mode**	In the past I had paper copies that I would hand them and they would fill in and give straight back to me right there and then. (C03)	6	7	13	51
		…a smart phone or an app or something…will definitely get more buy-in from athletes. (S04)				
Accessibility	**Technology**	…it would have to have the flexibility of…multiple sources of data entry, either from smart phone or from a computer (S10)	4	6	10	31
	Location	…when they go on tour and they don't have easy access to the internet…we lose big chunks of data (S12)	5	2	6	18
Compatibility	**Software**	…it doesn't work on a phone because it has to be computer based [software] (S05)	2	1	2	6
	Link with other data	…do you need that information about training load and time in [ASRM] when it's all [objectively recorded]? (A04)	1	2	13	27
Interface	**Appeal**	…usually the interfaces are very clinical and I don't think that grabs people. (S03) It's popular media, you've got to make it like funky and sexy you know, you've got to make it where they want to go there rather than have to go there. (S03)	0	0	5	13
	Complexity	…the more clicks the less compliant,…it has to be one page for one entry (S05)	2	2	8	25
Question design factors	**Question specificity**	…if it's too long or wordy or seems irrelevant, you actually get…[athletes] not liking it, and…don't want to have to do it (S11)	6	3	11	40
	Question sensitivity	…if your monitoring isn't sensitive enough, you're not going to find anything anyway. (S06)	0	1	3	6
	Scales	…what one person gives as a three, another person might give a five, that doesn't matter, as long as they are reporting it the same within themselves. (S08)	6	4	12	35
Time burden	**Time for completion**	…the onus is on developing [an ASRM] that's time efficient and short enough to keep the athletes happy but it does yield you important, valid information. (S13)	3	3	13	32
		…if I'm in a bit of a rush then I'd just quickly go through and like not really think about it (A02)				
	Frequency of completion	…it was frequent enough to give us good information but not too often that they got really annoyed at it. (S04)	3	2	5	17
		…when you're asking the same questions all the time day after day after day, some of them will just keep the same responses and they won't be honest, they'll just want to get this over and done with. (S04)				
		I think two to three times a week would prevent the chronic stuff and still give a good feel for the acute responses and trends.(S02)				

Table 1. Continued.

Higher order theme	Lower order theme	Representative meaning unit	Number of interviewees			Total meaning units
			Athlete (n=8)	Coach (n=7)	SSMS (n=15)	
Timing of completion	**Relative to training**	…they had to have [their ASRM data] in [prior to training], basically no data no training (S05)	2	2	7	16
		…if I do it in the morning its different to what I would have thought in the evening (A08)				
	Consistent	…we said "let's all do it at the same time every day" so that it becomes habit (C07)	6	3	6	17
		…we're relying on them to go into the system on a regular basis at the same time, and they don't do that (C03)				
	Retrospective	…if I skip say a week I'd always go back and fill in that week (A05)	8	2	2	14
		…it's more accurate when they do it the day of training rather than the next day or the day after, like giving witness testimony, it's more accurate the earlier it's done. (S08)				
Data output and analysis	**Red flag limits**	…based on certain thresholds in the criteria of each question (S15)	0	1	5	7
	Format of data output	…it comes as a summary statement to my email account (C02)	0	7	13	87
		...there is a lot of information there but...at the moment [it's] difficult to get all that information in a concise, easy to analyse/report format to be able to then use. (S01)				
	Data presentation	…they want to get information back quickly, easily in a format that is discernible to them...and the coach may want to see a little graph or just a warning. So does the information meet the criteria of what the coach wants? (C02)	1	5	15	64

The number of interviewees and total number of meaning units contributing to each lower-order theme are presented. Participant code follows each meaning unit. SSMS=Sports Science and Medicine Staff.
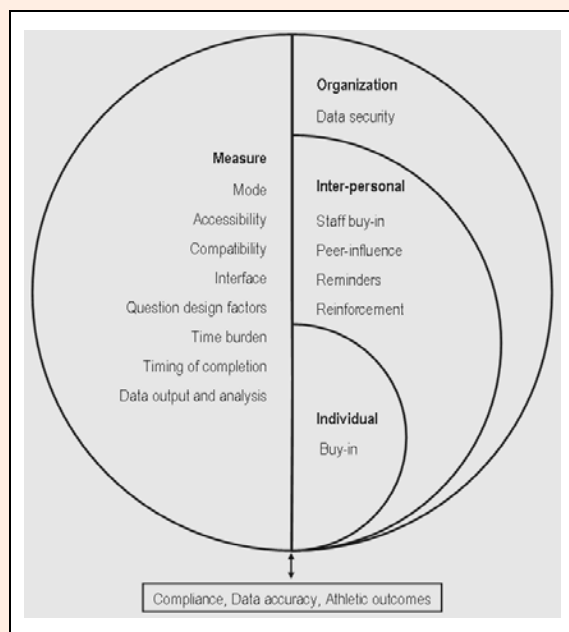

Figure 1. Factors perceived to influence the implementation of athlete self-report measures. Factors associated with the measure (left) and social environment (right) interrelate and influence the outcomes of implementation (compliance, data accuracy and athletic outcomes).

Factors associated with the measure

Mode: Interviewees had previous experience with paper-based measures which they favored for their relative simplicity, however the requirement for manual collection and data entry by staff was considered archaic. There was

a general consensus that paper-based ASRM were a method of the past. The uptake of technology was evident with all interviewees currently accessing an ASRM website on a computer.

Accessibility: Access to a computer with internet connectivity was adequate in the home training environment though posed a considerable challenge when in field settings or travelling. The development of applications for smart phone and other portable devices was seen as the 'next step' and 'the way to go' for ASRM, a view supported by 25 of interviewees.

Compatibility: Despite six interviewees already using portable device-enabled measures, they did not use this feature as the webpages were not designed for such devices and so were difficult to navigate or did not load properly. Similarly, incompatibility of the software with various operating systems, internet browsers and other athlete monitoring measures were other barriers to compliance.

Interface: Large file size, multiple pages and the number of steps or mouse clicks led to complaints of ASRM interfaces being 'clunky', 'cumbersome' and consequently taking 'longer than they should' to use. Instead, words used to describe an ideal interface included 'easy', 'simple', 'intuitive' and 'user-friendly'. Staff also suggested a 'less clinical' appearance and visual prompts to increase appeal to athletes and coaches.

Question design factors: Questions which seemed irrelevant to the athlete and their sport were a barrier to compliance whereas ambiguity compromised accuracy, as exemplified by an athlete's comment: 'I don't really know what general health is compared to sickness'. Athletes preferred to respond quickly on scales rather than enter

Table 2. Thematic structure of the influence of the social environment on athlete self-report measure (ASRM) implementation

Higher order theme	Lower order theme	Representative meaning unit	Number of interviewees			Total meaning units
			Athlete (n=8)	Coach (n=7)	SSMS (n=15)	
Athlete buy-in	Education	The data we put in will be more valuable if we understand what the benefits will be and what they are trying to get out of it. (A04)	1	2	7	11
		…some of the value in diaries is collecting them over a long long time…that's sometimes harder to sell because people want instant gratification for effort (S03)				
	Feedback	…if they think that no-ones looking at it then they'll just give dummy responses. (S04)	6	4	15	88
	When introduced	My thinking is that younger athletes…should be encouraged to be filling in diaries straight away so it becomes the norm not "this is all hard work". (C03)	0	2	2	5
Staff buy-in	SSMS buy-in	…it's really necessary to have everyone working with the sport supporting and following the benefits of the system (S12)	0	0	2	2
	Coach buy-in	…if it doesn't have a reinforcement from the coaches [compliance] tends to fall away. (S07)	4	1	12	24
		…within a team sport it is very much a coach-driven thing…then as a dictatorship, the coach can demand that it be done or there be ramifications to the athlete (S14)				
	Key staff-member	…you do need a couple of key drivers...instilling that everyone's got some individual obligation (S13)	3	1	8	19
		…because the interpretation of one person to another person could be completely different, so you've got to control how [the data] is used and who says what to the athlete (S07)				
Peer-influence		…people stop [completing their ASRM] and then everyone stops doing it and it stops completely (A03)	1	0	3	5
Reminders		I do remind them at probably two or three times a week I ask them why they haven't filled it out (S07)	1	6	11	24
Reinforcement		…we've included both carrot and stick in ways of trying to get them to do it (C06)	7	7	12	45
		…sometimes the athlete may want to hide something that's going on,… they might not want the coach to know…or worried they are going to get punished for it (S08)				
Data security		…some of them feel it reflects an invasiveness in to their privacy (S14)	1	1	6	11
		…their data is pretty much open to anyone that's got access, so maybe that is something [to address], the security side so the athletes feel confident that if they really want to write some stuff in there they can. (C03)				

The number of interviewees and total number of meaning units contributing to each lower-order theme are presented. Participant code follows each meaning unit. SSMS=Sports Science and Medicine Staff.

text, however they expressed concern of being compared against other athletes who may interpret a scale differently. Due to these limitations, the ability to also enter explanatory comments was perceived as valuable by athletes and staff.

Time burden: Current ASRM took a couple of minutes per day for both athletes to enter their data and staff to get a quick overview of their athletes. More comprehensive and/or frequent measures were suspected to yield data with 'a high level of integrity'. Yet interviewees also raised issues such as the normalization of responses (e.g. 'I always just record it as the same thing no matter how I'm feeling'(A05)); 'questionnaire fatigue' where athletes just go through the motions; and the process itself potentially influencing an athlete's perceived well-being (e.g. 'I wonder if constantly asking a player if they feel well makes them feel that maybe they don't.'(C07)).

Timing of completion: Completion of an ASRM prior to training was preferred by staff that used the data to determine the athlete's readiness for training or enforced a 'no data, no training' rule. However a couple of athletes felt this was inaccurate as 'I don't know how I'm feeling straight out of bed, I need a session to know how I'm feeling'(A06). If given the choice, athletes tended to complete their ASRM at the end of the day, however it was also commonplace for athletes to retrospectively record data for days or weeks missed. Some would enter data from their memory 'because I kind of know how I'm feeling for that week' whilst others referred to their own hand-written diary.

Data output and analysis: Software features such as real-time or daily emails to staff were considered time efficient, keeping staff on top of the data without having to directly access the ASRM software. Basic data output included a single 'snapshot' of an individual or squad's entries which staff could quickly scan and be alerted to any red flags. The limits for red flags were able to be

customized, however there was some ambiguity as to what these limits may be with vague comments such as data being 'outside normal healthy ranges'.

Factors associated with the social environment

Athlete buy-in: All factors of the ASRM and social environment raised by interviewees had an influence on athlete buy-in and consequently compliance and data accuracy. Staff often mentioned trying to 'sell' ASRM to the athletes, though suggested other approaches which may be more effective including education, feedback and introducing the measure to athletes earlier in their career. Interviewees suggested the scope of education should include why an ASRM is to be used, the purpose of questions, who looks at the data and how data is to be used to their benefit, and not used to their detriment. Feedback is a means of providing evidence of the above, whether it be a simple comment such as "I saw that you reported this", a report or action taken in response to the data.

Staff buy-in: Engagement of staff in the process was considered essential, with particular emphasis on coach buy-in and the need for a key-staff member to oversee the day-to-day operations of the ASRM. Five of the athletes interviewed felt that their coach had some resistance to ASRM with reasons including a preference for verbal communication; a lack of expertise to interpret the data; just being a messenger for SSMS; and a resistance to deviate from traditional methods of coaching. (e.g. 'I think [our coach is] a bit old fashioned...so no matter how you're feeling, how you're sleeping, you do the yards on the field.'(A01)).

Peer-influence: Interpersonal dynamics, particularly in a team setting, were also at play. Athletes vying to make a good impression, or who were in contact with complying athletes tended to have good compliance, whereas in the absence of these, compliance was poor. The commitment of staff to ASRM use was also positively related to the commitment of fellow staff.

Reminders: The role of reminding non-compliant athletes was largely undertaken by the key staff-member. Emails were favored for allowing athletes to act immediately if read on a computer, and the coach could be copied in to create an additional incentive. Other forms of reminders were talking to the athlete at training or sending them a mobile text message. This burden on staff to check compliance and chase athletes was partly alleviated by software automation.

Reinforcement: Positive reinforcement was mentioned by six staff as a means to encourage compliance, though with limited success. Instead, staff adopted punishments to try and rectify poor compliance. Punishments included added training, having to miss training and publicly shaming the athletes. However such a culture was to the detriment of data accuracy, with athletes carelessly completing their ASRM just to avoid punishment. Fear of punishment also resulted in deliberate dishonesty, with half of the athletes admitting withholding the truth on occasions as they did not want to appear 'unprofessional' or 'lacking motivation'.

Data security: Athletes would also withhold information over concern for who had access to their data.

When asked who looks at their data, some responded 'I honestly don't know' whilst others guessed or listed only a few of the multiple staff with access. One staff felt this was an issue of informed consent that needed to be addressed.

Discussion

This study identified the perceived factors influencing the implementation of ASRM in elite sports as summarized in Figure 1. The findings agree with existing implementation literature in other sporting (Ekegren et al., 2014a; Emery et al., 2006; Finch and Donaldson, 2010; Shrier et al., 2014) and non-sporting contexts (Durlak and DuPre, 2008; Meyers et al., 2012), and highlight the importance of both the design of the system, and social ecological influences. The complex interrelations of these factors ultimately determine athlete compliance, data accuracy and how the ASRM may be used to optimize athletic outcomes. The success of these outcomes reflects back upon these factors to reinforce or undermine the process. Hence to improve the implementation and use of ASRM, a sustained, multi-level approach is likely to be most effective (Jackson et al., 2006).

Factors associated with the measure

The anticipated purpose of ASRM is regular, ongoing monitoring to enable the evaluation and adjustment of athletic preparation. This, along with consideration of practical limitations, should dictate the structure, scope and output of ASRM. The move to technology reflects the preferences of today's athletes and staff, with access to various devices and automation of processes commonplace. Recent studies have demonstrated successful adoption of technology for injury monitoring (Clarsen et al., 2014; Ekegren et al., 2014b). Other benefits of technology include time-stamping entries, validating responses, skip logic and automated alerts, however technical issues are a potential barrier (Ekegren et al., 2014a). As technology continues to evolve, an ongoing investment is required to maintain currency and ensure accessibility and compatibility. The design of an ASRM may be further streamlined with the development of an 'app', following a user-centred design philosophy (Allen and Chudley, 2012) and incorporating elements of social media such as the ability to communicate with staff and peers.

The particular composition of the ASRM in terms of questions and scales is an area requiring further attention in the literature, and beyond the scope of this study, however it should be noted that athletes found it difficult to respond to very broad questions on their wellbeing. Athletes differ on their ability to introspect and respond accurately on an ASRM (Hassmen et al., 1998; Shrier et al., 2014), however a consistent approach from athletes may ensure validity (Shrier et al., 2014). Daily completion of the same questions may be bothersome to athletes (Shrier et al., 2014) and lead to questionnaire fatigue whereby athletes respond in an unvarying or random manner (Halson, 2014; Meeusen et al., 2013), hence it is important to consider the frequency of administration and balance this against the length of the measure.

In the literature, daily (Zerguini et al., 2008) or twice-daily (Kenttä et al., 2006) monitoring have been used to monitor constructs particularly sensitive to change and during acute phases; whereas weekly (Main et al., 2009), monthly (Brink et al., 2012) or infrequent monitoring (Cresswell, 2009) have been used for more stable constructs and longer-term outcomes. Yet for ongoing data collection with prospective application, there is a paucity of research to suggest an ideal frequency. Insight from the well-researched area of measuring food intake supports completion on non-consecutive days to reduce burden and the normalization of responses (Rankin et al., 2010). Alternatively, a brief daily or weekly measure may be supplemented periodically with a more comprehensive measure, which is consistent with previous recommendations (Botterill and Wilson, 2002).

Consideration of the timing of completion centres around the influence of training on subjective responses. Performance at training can acutely influence mood ratings (Hassmen and Blomstrand, 1995), whilst measures of mood disturbance, in particular fatigue and vigor, are sensitive to an athlete's recovery state (Kenttä et al., 2006). The response set used, for instance "right now", "today" or "in the past week" is also of relevance, with longer periods of recall more susceptible to error. However, experienced athletes have been shown to have high recall accuracy (Hanin, 2007; Tenenbaum et al., 1994), possibly due to the saliency of the information to their athletic goals. Whilst retrospective responses may be permissible over a short period, persistent poor compliance reflects flaws in how the ASRM is implemented which need to be addressed.

The final aspect of the measure, data output and analysis, is an important stimulus for ongoing use. However no staff mentioned receiving any training or guidance on this, hence were left to devise their own approach. The use of varied and arbitrary red-flag limits is a finding consistent with Taylor et al. (2012). Whilst further research is needed to guide this process, it is unlikely that specific guidelines for red flag determination will be established given considerable intra- and inter-individual variability. Retrospective studies have also demonstrated thresholds to be dynamic across the season (Gabbett, 2010) and leading to instances of both false positives and false negatives (Foster, 1998). Beyond red-flagged responses, analysis of data and report generation requires both time and expertise of staff, a shortfall which may be addressed through automation and the provision of training. It is essential that the data is synthesized and presented in a manner which is meaningful to the athlete or coach for applicability and also buy-in to the process.

Factors associated with the social environment

The factors of the social environment reflected the interplay of individual, inter-personal and organizational levels, consistent with a social ecological framework. At the individual level, the perceived importance of an ASRM to their preparation or role in supporting athlete preparation was a key motivator. This finding is consistent with that of Ekegren et al. (2014a) who also identified a sense of responsibility as another individual factor. Individual perceptions reflect understanding and prior experiences (Pennebaker, 2000), which may also be influenced by others (Cialdini and Trost, 1998). Therefore an implementation strategy should aim to positively influence the perceptions of all end-users.

Foremost is the provision of education and training by the organization. Earlier exposure, where possible, and persistence with the system are also recommended, as understanding and buy-in may increase with use (Berglund and Safstrom, 1994). Uncertainty over data security, or use of coercion or punishment to enforce ASRM completion reduces an athlete's sense of autonomy. This is not only detrimental to the ASRM process but may also impair their self-esteem and the athlete-coach relationship (Mageau and Vallerand, 2003). Instead, an autonomy-supportive culture is recommended to benefit athlete motivation and persistence with the process (Mageau and Vallerand, 2003).

Achieving individual buy-in would encourage an ideal scenario whereby the ASRM process is self-driven by athletes and staff. However it is unrealistic to expect all individuals to be motivated to the same degree and so differing approaches may be needed. In such cases, the key staff member noted in the present study plays an important role in encouraging and coordinating the ASRM process by communicating with athletes and other staff. The need for such support and leadership is also consistent with the findings of Ekegren et al. (2014a) and reflects the hierarchical structure within sports (Emery et al., 2006).

In considering the ecological factors of ASRM implementation, it is important not to lose sight of the fact that ASRM are only one measure for athlete monitoring. It is recommended that ASRM be incorporated alongside training, physiological and performance measures (Coutts and Cormack, 2014; Halson, 2014; Kellmann, 2010; Twist and Highton, 2013). Therefore the overall burden on athletes and staff should be considered. A multifaceted approach also highlights the importance of leadership to coordinate various inputs and facilitate a unified approach to athlete preparation.

Limitations and future directions

It must be acknowledged that this study did not attempt to reveal an exhaustive list of factors or represent all end-users and sports setting. Consequently, limitations relate to the small sample size and the breadth of their ASRM and sports setting experience. Further research is needed to investigate the influence of different dynamics in a professional sport environment, or at a lower-level where staff and resources are reduced. Future research should also seek the views from those in higher levels of management to investigate the influence of policies, funding and competing priorities on the perceived factors influencing the implementation of ASRM in elite sports.

This study contributes both theoretical and practical insight to the implementation of ASRM in the applied sport setting. From a theoretical perspective, the complex interrelations between the measure, social environment and outcomes were illustrated. The social environmental factors related to organizational, inter-personal and indi-

vidual levels as per the social ecological model. From a practical perspective, this study highlights the need for a multi-factorial and multi-level approach to address ASRM implementation.

Specific recommendation for the measure includes a design which obtains quality, meaningful data from the athlete with minimal burden. This means careful consideration of the questions, number of questions and frequency of completion along with effective utilization of technology. The organization then has a role in facilitating implementation of the measure through the ongoing investment in staff and resources, and establishing a positive culture through education and trust in the process. Such a culture is further supported by the perceptions and actions of the end-users. These recommendations remain general however, as ultimately the implementation of ASRM will be unique to the sports program and their short and long-term goals. Implementation practices may also be further tailored to meet the needs of individuals within the program.

Conclusion

This study contributes both theoretical and practical insight to the implementation of ASRM in the applied sport setting. From a theoretical perspective, the complex interrelations between the measure, social environment and outcomes were illustrated. The social environmental factors related to organizational, inter-personal and individual levels as per the social ecological model. From a practical perspective, this study highlights the need for a multi-factorial and multi-level approach to address ASRM implementation.

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